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Mechanical vibration — Torsional vibration of rotating machinery —

Part 1:
Evaluation of steam and gas turbine generator sets due to electrical excitation

Vibrations mécaniques — Vibration de torsion des machines tournantes —

Partie 1: Évaluation des groupes électrogènes à turbine à vapeur et à gaz due à l'excitation électrique

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Foreword

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This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This second edition cancels and replaces the first edition (ISO 22266-1:2009), which has been technically revised.

The main changes are as follows:

— terms and definitions revised to account for definitions given in other standards;

— evaluation concept refined and substantiated, contradictory statements removed;

— guidance on modelling uncertainties added;

— annex enhanced to give guidance on measurement equipment for monitoring torsional vibration;

— wording at some instances revised in order to make the content unambiguous;

A list of all parts of the ISO 22266 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

During the 1970s, a number of major incidents occurred in power plants that were deemed to be caused by or that were attributed to rotor torsional vibration. In those incidents, generator rotors and some of the long elastic turbine blades of the LP rotors were damaged. In general, the incidents were due to vibration modes of the coupled shaft and blade system that were resonant with the grid electrical excitation frequencies. Detailed investigations were carried out and it became apparent that the mathematical models used at that time to predict rotor torsional natural frequencies were not adequate. In particular, they did not take into account, with sufficient accuracy, the coupling between long elastic turbine blades and the shaft line. Therefore, advanced research work was carried out to analyse the blade-to-disc-to-shaft coupling effects more accurately and branch models were developed to account properly for these effects in shaft train torsional natural frequency calculations.

In the 1980s, torsional factory tests were developed to verify the predicted torsional natural frequencies of LP rotors. These factory tests were very useful in identifying any necessary corrective actions before the product went into service. However, it is not always possible to test all the elements that comprise the assembled rotor. Hence, unless testing is carried out on the shaft train on site, some discrepancies could still exist between the overall system model and the installed machine.

There is inevitably some uncertainty regarding the accuracy of the calculated and measured torsional natural frequencies. It is therefore necessary to design shaft train torsional natural frequencies with sufficient margin from the grid system frequencies to compensate for such inaccuracies, unless the modes are insensitive to excitation torques. Acceptable margins will vary depending on the extent to which any experimental validation of the calculated torsional frequencies is carried out. The margins should also take into account the sensitivity of the torsional natural frequencies and the modal excitability with respect to modelling uncertainties. The main objective of this document is to provide guidelines for the selection of frequency margins during the design stage and on the fully coupled shaft train on site.

In general, the presence of a torsional natural frequency is only of concern if it coincides with an excitation frequency and has a modal distribution allowing energy to be fed into the corresponding vibration mode (resonance). If either of these conditions is not satisfied, the presence of a natural frequency is of no practical consequence (e.g. a particular mode of vibration is of no concern if it cannot be excited). In the context of this document, the excitation is due to variations in the electromechanical torque, induced at the air gap of the generator. Any shaft train torsional modes that are insensitive to these induced excitation torques do not present a risk to the integrity of the turbine generator, regardless of the value of the natural frequency of that mode.